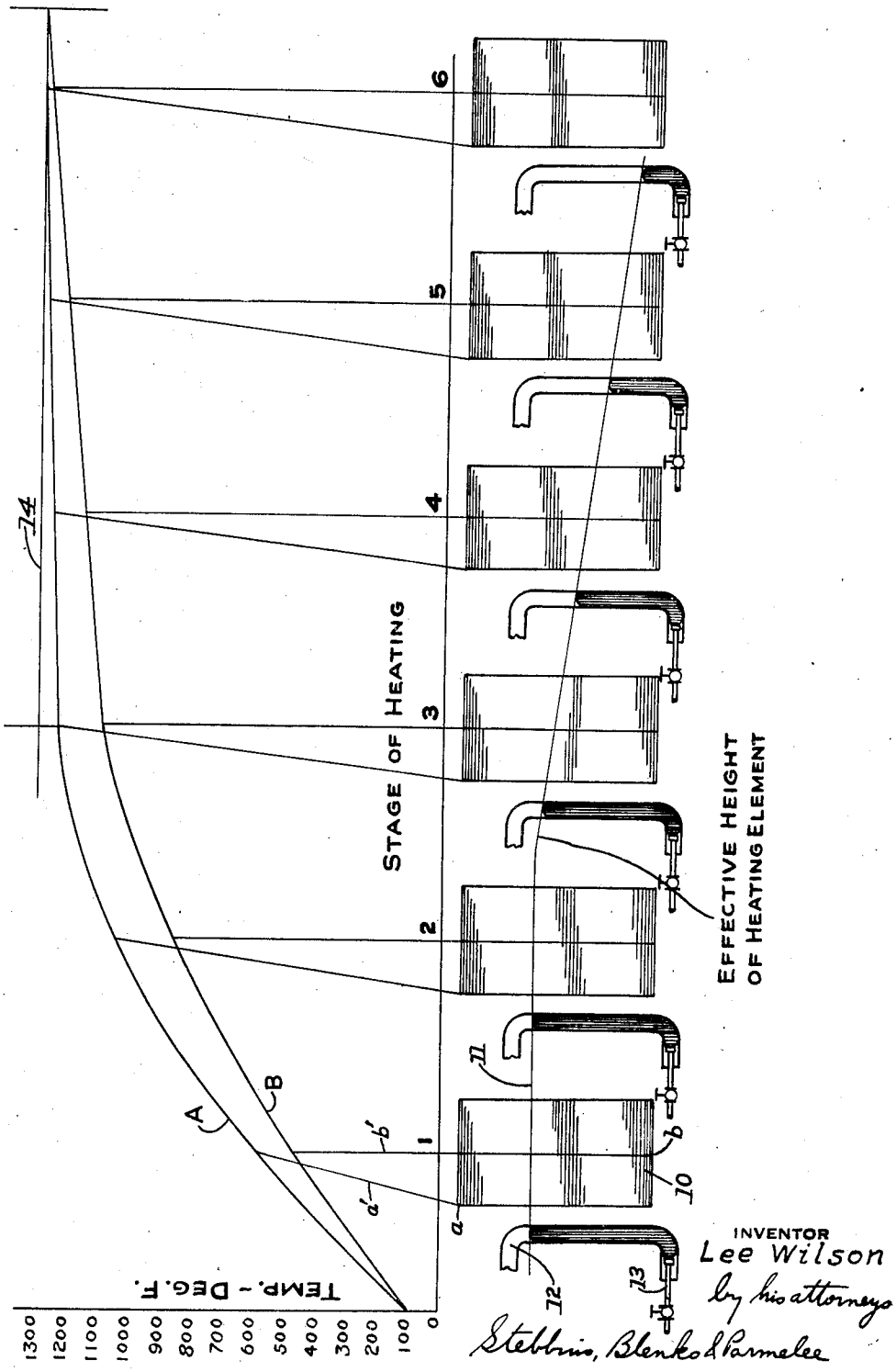
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METHOD OF ANNEALING

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INVENTOR
Lee Wilson
by his attorneys
Stebbins, Blenko & Parmelee

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METHOD OF ANNEALING

Lee Wilson, Cleveland, Ohio

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7 Claims. (Cl. 266—5)

This invention relates to the art of annealing.

In the annealing of material such as sheets or coils, difficulty has been experienced in preventing wide variations in the temperature of different parts of the charge at different times. For a high quality product having uniform characteristics, it is essential that all portions of the charge be heated to substantially the same annealing temperature. Any considerable variation in the temperatures of different parts of the charge means that the portions of the charge heated to the higher temperatures are overheated and perhaps burned, while those portions heated to the lower temperatures are not properly annealed. It is an object of this invention, therefore, to provide a method of annealing whereby all parts of a charge are heated to substantially the same temperature.

In accordance with the invention, I deliver heat to the charge throughout a portion or all of its height initially. As the temperature of the charge rises, I progressively decrease the portion of the charge height to which heat is delivered. The heat delivered adjacent the lower portion of the charge soaks upwardly through the charge and heats the upper portion thereof.

A preferred practice of the invention is indicated diagrammatically on the accompanying drawing which shows temperature curves for two points in a charge at various stages of heating and, schematically, the portions of the charge subjected to the application of heat at such stages.

In carrying out the invention, a charge 10 is heated throughout a portion of its height extending upwardly from the bottom to a line 11. The heat may conveniently be applied by disposing the charge in the furnace of the type shown in my Patent No. 1,952,402 and controlling the pressure of fuel supplied to the radiant tubes thereof, such as indicated at 12, so that the tubes are heated to a radiant condition from a point adjacent the burners 13 in the lower ends thereof to the level of the line 11. During this first stage of the heat treatment, the charge is heated from the beginning temperature which may, as shown by the diagram, be anything up to 100° F., to an intermediate temperature. The temperature of a point *a* on the charge 10 rises along a curve A. The temperature of a point *b* at the bottom of the charge rises along a curve B. The connecting lines *a'* and *b'* extending from the points *a* and *b* on the charge to the points on the curves A and B, represent the temperature of the points *a* and *b* at the end of the first stage of the heating cycle. While there is a slight difference in the temperatures of the points *a* and *b*, it is not great enough to be objectionable.

During the second stage of the heating cycle, conditions continue as before, the temperature of the points *a* and *b* increasing, as shown by the curves A and B.

During the third heating stage, the increase in the temperature of the points *a* and *b* continues until the temperature of the point *a* is a predetermined amount, say 50°, below the maximum desired temperature indicated by the line 14. At this point, I commence a progressive reduction in the effective height of the radiant tube 12. I do this by reducing the pressure of the fuel so that the column of highly heated combustion gases is shortened with the result that the tubes 12 are effective to radiate a substantial amount of heat from only a reduced portion of their height measured upwardly from the bottom thereof. While the upper ends of the tubes 12, at all heating stages, are not cold, their temperature is not sufficiently high to cause them to radiate a substantial amount of heat to the charge.

Similar procedure characterizes the final stages of the heating cycle. The effective height of the radiant tubes 12 is decreased progressively as the temperatures of the points *a* and *b* approach the maximum desired value. The difference between these temperatures also decreases simultaneously until at the end of the last stage, the temperatures of both points are equal to the desired maximum value.

It will be apparent that, in effect, the invention contemplates disposing a charge alongside one or more heating elements of variable effective length, and reducing the effective length of the elements as the temperature of the charge rises. While I have described the invention as applied to the annealing of sheets in stacks, it is also applicable to the annealing or other heat treatment of material in other forms such as coils and the like.

The method described above is advantageous since it limits the difference between the temperatures of the hottest and coldest parts of the charge, and also from the standpoint of fuel economy. It will be understood, furthermore, that the invention is applicable not only to gas-fired furnaces, but also to electric furnaces, for example. For such application, it will only be necessary to arrange the electrical heating elements in groups, so that they can be successively disconnected from the current source, thus re-

ducing the effective height of the heating elements disposed alongside the charge.

While I have illustrated only a preferred practice of the invention, changes in the procedure described may be made without varying the principle involved. Such variations are intended to be comprehended within the scope of the appended claims.

I claim:

1. In a method of annealing a charge of material, the steps including radiating heat to the charge throughout a substantial portion of the height at the bottom thereof, and radiating heat to the charge throughout a lesser portion of its height as the temperature of the charge approaches the desired annealing value.

2. In a method of annealing a charge of material, the steps including radiating heat to the lower portion of the charge and a substantial portion of the height of the charge measured upwardly from the bottom thereof, and radiating heat to a portion of the height of the charge above the bottom decreasing progressively as the heating of the charge proceeds.

3. In a method of annealing a charge of material, the steps including radiating heat to a substantial portion of the height of the charge at the bottom thereof and radiating heat to a smaller portion of the charge height as the heating progresses.

4. In a method of heating all portions of a charge of material to substantially the same heat treating temperature, the steps including delivering heat to the lower portion of the charge and a substantial portion of the height of the charge thereabove, and subsequently delivering heat to the lower portion and a lesser portion of the height of the charge.

5. In a method of annealing a stack of sheets, the steps including initially radiating heat to a substantial portion of the height of the stack measured upwardly from the bottom thereof, and as the charge comes up to annealing temperature, radiating heat to a progressively decreasing portion of the height of the stack measured upwardly from the bottom thereof.

6. In a method of heating all parts of a charge of material to substantially the same temperature, the steps including first applying heat to the lower portion of the charge and a portion of the height thereof above the bottom, and later applying heat to a lesser portion of the height of the charge above the bottom.

7. In a method of annealing a charge of material, the steps including disposing the charge adjacent a heating element of variable effective height, and reducing the effective height of said element progressively as the temperature of the charge increases.

LEE WILSON.